CHAPTER 7

INTERNET RESOURCES FOR BIOLOGICAL SOIL CRUSTS

The Internet has a number of valuable resources for information on biological soil crusts or the organisms that comprise crusts (lichens, algae, etc.). Below we have listed several of the most useful web pages currently available.

Web Address	Author or Organization	Description
www.soilcrust.org	U.S. Geological Survey (Jayne Belnap) Bureau of Land Management National Park Service	Biological soil crust information, based in Canyonlands National Park. This web page contains a near exhaustive bibliography for all things crust-like and a recent version of this reference.
www.id.blm.gov/iso/soils/index.html	Bureau of Land Management, Idaho State Office	This site contains an introduction to soil biological communities, including soil crusts and subsurface micro-and macro-organisms.
www.ucmp.berkeley.edu/fungi/lichens/lichens.html	University of California, Berkeley, Museum of Paleontology	Introduction to lichens.
www.unomaha.edu/~abls/resources.html	American Bryological and Lichenological Society (ABLS)	Checklists and floras; links to institutions and individuals that are resources for information on nonvascular plants and lichens.
mgd.nasce.org/hyperSQL/lichenland	Department of Botany and Plant Pathology, Oregon State Univ.	One of the best introductions to lichens, complete with great color photos.
ucs.orst.edu/~mccuneb/	Bruce McCune Oregon State University	Bruce McCune is a leading ecologist in North America and specializes in lichen and moss ecology and taxonomy.

Web Address	Author or Organization	Description
www.ndsu.nodak.edu/instruct/esslinge/chcklst/chcklst7.htm		
	Theadore Esslinger Department of Botany North Dakota State University	*Cumulative Checklist for the Lichen-forming, Lichenicolous and Allied Fungi of the Continental United States and Canada.*
www.fs.fed.us/land/ecosysmgmt/ecoreg1_home.html		
	USDA Forest Service Robert G. Bailey	Descriptions of Bailey's ecoregions of the U.S., including maps.
www.accessexcellence.org/BF/bf05/johansen/web.html		
	California Academy of Sciences Jeffrey Johansen	Text of a talk presented to high school teachers for the California Academy of Sciences. A layman's introduction to biological crust, focusing on algal and cyanobacterial components and research on inoculation to speed recovery following disturbance.
www.biblio.bio.purdue.edu/www-cyanosite		
	Department of Biology, Purdue University; Foundation for Microbiology	Web server for cyanobacterial research; includes a link to CyBib, a bibliographic database containing references on cyanobacteria.

GLOSSARY

adnate: Pressed closely against a surface.

aggregate stability: The degree to which a group of soil particles cohere so as to behave mechanically as one unit.

albedo: A measure of the energy reflected off a surface. Dark surfaces have a lower albedo than light surfaces; therefore, light surfaces absorb less energy than dark surfaces.

ammonia volatilization: The vaporization of ammonia into the atmosphere.

anaerobic: The absence of oxygen. Also refers to organisms able to live or grow in the absence of free oxygen.

appressed: Pressed closely against a surface.

autotroph: An organism whose growth and reproduction are independent of external sources of organic compounds. Carbon compounds are created by autotrophic organisms via the reduction of carbon dioxide (CO_2), with light energy driving the process.

bacteria: Members of a group of diverse and ubiquitous prokaryotic, single-celled organisms.

bryophytes: Tiny plants lacking vascular tissues. This group includes mosses and liverworts.

calcareous: Substrates rich in calcium carbonate, such as limestone or dolomite. Also refers to soils derived from or containing these substances.

cosmopolitan: Found worldwide.

crustose lichens: Lichens that form a crust-like growth form that is closely applied to the substrate.

cyanobacteria: "Blue-green" algae; prokaryotic, photosynthetic organisms that generally have a blue-green tint and lack chloroplasts.

cyanolichen: Lichen that contains a cyanobacterium as its phytobiont.

denitrification: The formation of gaseous nitrogen or gaseous nitrogen oxides from nitrate or nitrite by microorganisms.

desertification: Land degradation in arid, semi-arid, and dry subhumid regions of the world resulting from climatic and other natural stresses coupled with human activities. Processes that lead to desertification include soil loss through wind and water erosion; changes in soil quality due to salinization, waterlogging, and nutrient depletion; loss of vegetative biomass and cover; and compositional and structural changes in plant communities due to exotic plant invasion (Mouat et al. 1995).

foliose lichens: Lichens that are leaf-like in growth form, flattened with definite upper and lower surfaces, and usually loosely attached to the substrate.

fruticose lichens: Lichens with three-dimensional growth forms that are ropey or branching and do not have definite upper and lower surfaces.

gelatinous lichens: Lichens that are non-stratified (algal and fungal layers are not distinct) and that have a jelly-like appearance when moistened. All gelatinous lichens have cyanobacteria as their phytobiont.

gemmae: Structures produced by liverworts that function in vegetative reproduction.

green algae: Photosynthetic unicellular and multicellular organisms that lack true tissue differentiation.

heterocysts: Specialized cells occurring in some filamentous cyanobacteria that are the sites of nitrogen fixation.

heterotrophs: Organisms that require organic compounds for growth and reproduction.

***hydraulic conductivity (K_s)*:** The rate at which water moves through the soil profile under field conditions.

***hyphae*:** Fungal filaments.

***infiltration*:** The downward entry of water into the soil.

***interspace*:** The spaces in a plant community between shrubs or trees.

***lichen*:** A symbiotic relationship between a fungus and an algae or cyanobacterium.

***lithic*:** Pertaining to rock; rocky.

***liverwort*:** A small, non-vascular plant.

***microfungi*:** Fungi that occur free-living in the soil or in association with roots of vascular plants (mycorrhizae).

***mucilaginous*:** Having a sheath composed of sticky polysaccharides surrounding cyanobacterial, algal, or fungal filaments.

***mycorrhizae*:** A stable, symbiotic association between a fungus and the root of a plant.

***nitrification*:** The process in which ammonia is oxidized to nitrite and nitrite to nitrate.

***nitrogen fixation*:** The conversion of elemental nitrogen (N_2) to organic combinations or to forms readily usable in biological processes.

***nitrogenase*:** The enzyme that catalyzes biological nitrogen fixation.

***permeability*:** The ease with which gases, liquids, or plant roots penetrate or pass through the soil.

***photosynthesis*:** The process in which light energy is absorbed by specialized pigments of a cell and converted to chemical energy. The ultimate result of photosynthesis is the fixation of CO_2 and the production of carbon compounds (sugars).

***phytobiont*:** The photosynthetic partner in the lichen symbiosis, i.e., the algal or cyanobacterial component of a lichen.

***poikilohydric*:** Organisms that are capable of becoming physiologically dormant under dry conditions.

***prokaryotic*:** Cells that lack a nucleus.

***propagules*:** Material that results from either sexual or asexual reproduction by crustal organisms and disperses into areas where the biological soil crust has been removed by disturbance. This material "germinates" and grows to establish a new crust.

***resilience*:** The ability to recover following disturbance.

***resistance*:** The ability to withstand disturbance.

***respiration*:** The biological process whereby organisms oxidize carbon compounds to CO_2 and water as a source of energy.

***rhizines*:** Root-like structures of lichens and mosses that function to attach the organism to the substrate.

***saline soil*:** A soil containing sufficient soluble salts to impair its productivity.

***sessile*:** Attached to a surface without a stalk but not imbedded in the surface.

***squamulose lichens*:** Lichens that occur as discrete flakes or scales that are often round or ear-shaped. Squamulose lichens may be convex or concave and often have lobed margins.

***symbiosis*:** An obligatory, interactive association between two organisms, producing a stable condition in which they live together in close physical proximity to their mutual advantage.

***thallus*:** The vegetative body of a lichen or liverwort.

***xerothermic*:** Dry, hot conditions.

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This technical reference presents a review of current scientific knowledge on the ecology of biological soil crusts, then integrates this information into a discussion on monitoring and management of arid and semiarid lands in the western United States. The document begins with a discussion on the composition, structure, and distribution of biological crusts relative to environmental factors such as climate and soil characteristics. This information is then synthesized into guidelines on development of monitoring strategies as well as site-specific management prescriptions regarding livestock, recreation, and other multiple-use activities. The material is presented from a practical and applied management perspective and is summerized in numerous tables and figures.

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